State of Illinois
Department of Transportation
Division of Aeronautics

POLICY MEMORANDUM

January 1, 2004   Springfield   Number: 87-2

TO: CONSULTING ENGINEERS

SUBJECT: DENSITY ACCEPTANCE OF BITUMINOUS PAVEMENTS

1. Introduction

This Policy Memorandum deals with the implementation of the Bituminous Density
Quality Assurance specifications as a revision to the Standard Specification for
Construction of Airports, January 1985. These revisions are to Item 201
Bituminous Base Course, and Item 401 Bituminous Surface Course.

II. Sampling

After completion of compaction and the pavement has reached ambient
temperature, the paved area shall be divided into Sublots of 500 tons per type of
mix. One core sample (2 cores per sample) shall be taken from each Sublot. The
longitudinal and transverse location for each sample shall be determined by use of
a random number "Deck" provided by the Division. No core shall be taken closer
than two (2) feet from the edge of the mat. A core extraction device as illustrated
by the attachment is recommended. All cores are to be taken by the contractor
under the supervision and remain in the possession of the engineer. It is imperative
that the Engineer and the contractor realize that the cores are "Money" and that
improper coring, extraction, shipping and/or testing can be costly.

One mix sample per 1000 tons of mix laid shall be taken for Extraction, Maximum
Specific Gravity (G_{mm}) and Air Void tests. The mix samples shall be sampled by the
contractor and split in half.

The Resident Engineer shall randomly designate and send the split samples to an
independent laboratory for testing. The laboratory will be designated by the
Division of Aeronautics. The frequency of testing split samples shall be 1 per 5000
tons. Higher frequencies may be necessary if the contractor's tests, and/or mix
quality control are inconsistent.

III. Testing

All cores shall be tested for Bulk Specific Gravity (G_{sb}) in accordance with ASTM D2726 using Procedure 9.1, "For Specimens That Contain Moisture". The Theoretical Maximum Gravity (G_{mm}) shall be determined according to ASTM D2041, Procedure 7. From these tests the in-place air voids of the compacted pavement are calculated according to ASTM D3203 for "dense bituminous paving mixtures". Selection of the proper G_{mm} shall be based on a running average of four (4) tests per Lot.

Eg. Lot 1 - Use the average of the two (2) tests for Lot 1.
    Lot 2 - Use the average of the four (4) tests from Lots 1 and 2.
    Lot 3 - Use the average of the four (4) tests from Lots 2 and 3.

    NOTE: When more than four (4) Sublots are used, still use a
            running average of four (4) tests per Lot.

IV. Acceptance Calculations

The first step in calculating the quantities for pay is to calculate the Mean ($\bar{x}$) and the Standard Deviation (S) of the Sublot tests. From this data the Lot samples should first be tested for outliers. After consideration for outliers, the Percent Within Tolerance (PWT) and the Percent Within Limits (PWL) are calculated to determine the final pay quantities for the Lot.

EXAMPLE

1.   Test Data
         Lot Quantity = 2000 tons
         Sublot Test 1 = 4.35 % Air
         Sublot Test 2 = 3.96 % Air
         Sublot Test 3 = 6.75 % Air
         Sublot Test 4 = 6.25 % Air

2.   Calculating the Mean and Standard Deviation

Sublot	x	$(x - \bar{x})$	$(x - \bar{x})^2$
1	4.35	- 0.978	0.956
2	3.96	- 1.368	1.871
3	6.75	1.422	2.022
4	6.25	0.922	0.850
Sum =	21.31		5.699

N   = 4

Mean($\bar{x}$) = 5.328

Variance $(S)^2 = \dfrac{\text{Sum}(x - \overline{x})^2}{3} = \dfrac{5.699}{3} = 1.900$

Standard Deviation $S = \sqrt{1.900} = 1.378$

3. Test For Outliers

   Check for Critical "T" Values

   $T = \left|\dfrac{(x_1 - \overline{x})}{S}\right|^* = \dfrac{|3.96 - 5.328|}{1.378} = 0.99$

   * Difference between the suspect test value (x_1) and the Mean ($\overline{x}$).

   If the T value exceeds the critical "T" Value in the table below and no <u>assignable cause</u> can be determined for the outlier, discard the suspected test measurement and obtain another random sample from the Lot in question. If the new test exceeds the Mean ($\overline{x}$) in the same direction from the Mean as the suspected test, recalculate the T value including all tests (original test, suspected test, and new test) for an outlier and for computing final payment.

   <u>TABLE OF CRITICAL "T" VALUES</u>

Number of observations <u>(N)</u>	Critical "T" Value <u>5% Significance Level</u>
3	1.15
4	1.46
5	1.67
6	1.82
7	1.94
8	2.03
9	2.11
10	2.18
11	2.23
12	2.29

   Based on the above table, the "T" value of 0.99 does not exceed the Critical "T" Value of 1.46 for N = 4. Therefore, the value (3.96) is not an outlier and shall be used in calculating the Lot payment.

4. Calculation of Lot Payment

   To calculate the Lot Payment use the Acceptance Criteria as outlined under Item 201-4.13(c) or Item 401-4.13(c).

   $Q_L = \dfrac{(\overline{x} - 1)}{S} = \dfrac{5.328 - 1}{1.378} = 3.141$

$$Q_u = \left(\frac{7 - \bar{x}}{S}\right) = \frac{7 - 5.328}{1.378} = 1.213$$

From this data the Percentage Within Tolerance (PWT) for both the lower and upper tolerance limits is determined by Table 8 of the specifications for the number (N) of samples tested.

Eq. PWT (lower) = 99.0%
   PWT (upper) = 90.4%

We now calculate the Percent Within Limits (PWL) for the Lot.

PWL = [PWT (lower)] + [PWT (upper)] - 100
PWL = (99.0 + 90.4) - l00 = 89.4%

Using Table 7, the % Adjustment in Lot Quantity is:

% Adjustment = 0.5 PWL + 55.0
% Adjustment = 0.5 (89.4) + 55.0
% Adjustment = 99.7

Adjusted Quantities = % Adjustment x Lot Quantities
Adjusted Quantities = .997 x 2000 tons
Adjusted Quantities = l994 tons

5.   Resampling and Retesting

Under the specifications the contractor has the right to request the resampling and retesting of a complete Lot. This privilege is only allowed once for each Lot and must be requested in writing by the contractor within 48 hours of receiving the official report from the Engineer.

6.   Reporting

After completion of the tests for each Lot, the Engineer shall complete the necessary calculations for final adjustment in quantities on the Form AER M-1 and have both the Engineer and the Contractor sign the report for copying to both the FAA and IDOA.

Steven J. Long, P.E.
Acting Chief Engineer

Supersedes Policy Memorandum 87-2, dated January 1, 1999.